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layer of membrane or multiple layers of different membrane to specifically only allow proton to cross over.

FIG. 2 shows another preferred embodiment with two separators 3. Between the separators 3 is intermediate electrolyte 4. The device with separators 3 and intermediate electrolyte 4 separates the anodic electrolyte and cathodic electrolyte.

Tin has very low negative standard electrode potential, thus was not preferred in anode material selection in previous studies. However, iodate has high energy density and high water solubility but requires very acidic environment. Only tin could endure such an acidic environment. In order to use iodate, tin has to be used as anode. The good news is the actual open-circuit voltage 1.55 V is higher than expected, and the high solubility of stannous salt in acidic solution results in high energy density of the battery.

The energy density is usually measured as the amount of energy stored per unit weight of reactive redox species and can be calculated by the concentration of active species and voltage in the form of equation:

$$E = \frac{NFV}{m}$$

where N is the number of electrons involved in the redox reaction, here is 12, F is the Faraday constant (26.8 Ah mol<sup>-1</sup>), V is the voltage, m is the total mass of active species including solvent water, which depends on the solubility of active redox species. Thus the theoretical energy density of the tin-iodate battery can be calculated as 183 Wh/kg or 319 Wh/L. Practically 95 Wh/kg or 191 Wh/L can be achieved. This energy density is much higher than the commercialized traditional Lead-acid battery (30 Wh/kg) and vanadium redox flow battery (25-30 Wh/kg, 25 Wh/L), and is comparable with the low end of Li-ion battery (100-265 Wh/kg).

Experiments prove that the tin-iodate battery can discharge and be charged quickly at 350 mA/cm<sup>2</sup> with high power density. There are no problems of dendrite, over charge and over-discharge. Metal tin is so soft that the tin plating cannot break the separator membrane. Both tin and iodine are low toxic, renewable and reusable and the aqueous solution is inflammable, which make the system very safe and environmental friendly. Finally, the costs of tin and iodate are low as well. All the performance characteristics make the tin-iodate battery almost perfect for large-scale energy storage and electrified vehicles.

Although the invention has been described in detail for the purpose of illustration based on the currently considered embodiment, it is to be understood that such detail is solely for that purpose and that the invention is not limited to the disclosed embodiment, but, on the contrary, is intended to

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cover modifications and equivalent arrangements that are within the spirit and scope of claims.

What is claimed is:

1. A rechargeable tin-iodate battery, including a static battery and a redox flow battery, comprising:

a tin anode;

a carbon cathode;

a selective permeable separator for separating anodic stannous electrolyte and cathodic iodic electrolyte; and

aqueous acidic electrolytes,

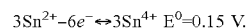
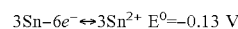
whereby electricity energy can be stored.

2. The rechargeable tin-iodate battery of claim 1 is capable of the following redox reactions:

Anode:	$3\text{Sn} - 6e^- \leftrightarrow 3\text{Sn}^{2+}$	$E^0 = -0.13 \text{ V}$
	$3\text{Sn}^{2+} - 6e^- \leftrightarrow 3\text{Sn}^{4+}$	$E^0 = 0.15 \text{ V}$
Cathode:	$2\text{IO}_3^- + 12\text{H}^+ + 10e^- \leftrightarrow \text{I}_2 + 6\text{H}_2\text{O}$	$E^0 = 1.20 \text{ V}$
	$\text{I}_2 + 2e^- \leftrightarrow 2\text{I}^-$	$E^0 = 0.54 \text{ V}$
Overall:	$3\text{Sn} + 12\text{H}^+ + 2\text{IO}_3^- \leftrightarrow 3\text{Sn}^{4+} + 2\text{I}^- + 6\text{H}_2\text{O}$	$E = 1.33/0.39 \text{ V}$

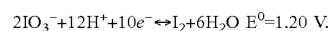
3. The rechargeable tin-iodate battery of claim 1, wherein said tin anode comprises at least tin or carbon.

4. The rechargeable tin-iodate battery of claim 3, wherein said tin anode is capable of at least one of the following redox reactions:



5. The rechargeable tin-iodate battery of claim 1, wherein said carbon cathode comprises carbon.

6. The rechargeable tin-iodate battery of claim 5, wherein said carbon cathode is capable of the following redox reaction:



7. The rechargeable tin-iodate battery of claim 1, wherein said selective permeable separator comprises at least one layer of membrane or a device with multiple membranes to separate anodic electrolyte and cathodic electrolyte.

8. The rechargeable tin-iodate battery of claim 1, wherein said aqueous acidic electrolytes include anodic stannous electrolyte and cathodic iodic electrolyte.

9. The rechargeable tin-iodate battery of claim 8, wherein said anodic stannous electrolyte comprises at least one acid.

10. The rechargeable tin-iodate battery of claim 8, wherein said cathodic iodic electrolyte comprises at least one of iodate, iodide, iodine, iodic acid.

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